What is claimed is:

1. *A method of manufacturing a photomask, the method comprising:*

providing a photomask that includes a substrate having a front side and a rear side, and a main pattern located at said front side of the substrate;

transferring an image of the main pattern to a wafer by directing illumination onto the wafer through said photomask in an exposure process, and using the image to produce a pattern on the wafer formed of elements having critical dimensions;

quantifying the critical dimensions to obtain a distribution of values of the critical dimensions on the wafer;

comparing the critical dimension values to a reference critical dimension value in order to ascertain the differences therebetween;

determining, in relation to localities on the photomask, degrees to which the intensity of the illumination used in the exposure process would need to be decreased in order to reduce the differences, respectively, between the critical dimension values and the reference critical dimension value, to thereby obtain a distribution of said degrees in relation to said localities;

selecting transparency-adjusting pattern features that, if provided in a set at a rear side of the substrate of the photomask during the exposure process, would change the intensity of the illumination passing through the photomask during the exposure process due to the density of the features in terms of their size and spacing;

obtaining a correlation between the densities of the transparency-adjusting pattern features, in terms of their size and spacing, and the changes that the transparency-adjusting pattern features provided at those densities at the rear side of the substrate would make in the intensity of the illumination directed therethrough during the exposure process;

based on said correlation, ascertaining the densities of the transparency-adjusting pattern features that correspond to said distribution of the degrees to which the intensity of the illumination needs to be decreased, to thereby obtain a distribution of the densities of the transparency-adjusting pattern features in relation to said localities; and

providing the transparency-adjusting pattern features at the rear side of the substrate in an arrangement corresponding to said distribution of the densities of the transparency-adjusting pattern features.

2. The method of claim 1, wherein the reference critical dimension value is the smallest of the critical dimension values.

3. The method of claim 1, wherein said obtaining a correlation between the densities of the transparency-adjusting pattern features and the changes that the transparency-adjusting pattern features would make in the intensity of the illumination during the exposure process comprises:

forming an arbitrary arrangement of the selected the transparency-adjusting pattern features at the rear side of the photomask substrate; the arrangement comprising an arbitrary size of the transparency-adjusting pattern features spaced apart an arbitrary distance from each other;

using a Fourier transform, determining the intensity of illumination incident on the main pattern after the illumination has been modified by the arbitrary arrangement of the transparency-adjusting pattern features in the exposure process as a function of the size and the spacing of the arrangement of the selected the transparency-adjusting pattern features; and

based on said function, obtaining a correlation between the densities of the transparency-adjusting pattern features, represented by $\frac{(\textit{the size of the features})^2}{(\textit{the spacing of the features})^2}$, and the changes that the transparency-adjusting pattern features would make in the intensity of the illumination during the exposure process.

4. The method of claim 3, wherein the intensity of illumination is represented by $\frac{1-4(\textit{the size of the features})^2}{(\textit{the spacing of the features})^2}$ in said function.

5. The method of claim 1, wherein said determining degrees to which the intensity of the illumination used in the exposure process would need to be decreased comprises:

ascertaining dose latitude values representative of variations in a critical dimension of a pattern formed by an exposure process with respect to changes in the dose of the illumination used to form the pattern; and

calculating exposure dose variations, corresponding to the differences between the critical dimension values and the reference critical dimension value, using the dose latitude values and said differences.

6. The method of claim 1, wherein said providing the transparency-adjusting pattern features at the rear side of the substrate comprises etching the rear side of the substrate to form recesses therein.

7. The method of claim 1, wherein said providing the transparency-adjusting pattern features at the rear side of the substrate comprises forming over the rear side of the substrate a shielding layer of material that is opaque with respect to the illumination, and selectively etching the shielding layer.

8. The method of claim 7, wherein the shielding layer comprises chromium.

9. The method of claim 1, wherein said providing the transparency-adjusting pattern features at the rear side of the substrate the transparency-adjusting pattern layer comprises providing a transparent auxiliary

mask substrate on the rear side of the photomask substrate, and forming the transparency-adjusting pattern features at one side of the auxiliary mask substrate.

10. The method of claim 9, wherein said forming of the transparency-adjusting pattern features comprises selectively etching the auxiliary mask substrate.

11. The method of claim 9, wherein said forming of the transparency-adjusting pattern features comprises forming a shielding layer of a material that is opaque with respect to the illumination over the rear side of the auxiliary mask substrate, and selectively etching the shielding layer.

12. The method of claim 11, wherein the shielding layer comprises chromium.

13. A method of manufacturing a photomask, the method comprising:

providing a photomask that includes a substrate having a front side and a rear side, and a main pattern located at said front side of the substrate; and

providing substrate transparency-adjusting pattern features, capable of changing the intensity of illumination directed through the rear side of the photomask and onto the main pattern, in respective sections at the rear side of the substrate, the transparency-adjusting pattern features having a density in each of the sections that

is a function of the size and spacing of the features and is proportional to the change that the features will make in the intensity of the illumination when the illumination is directed through the rear side of the substrate, and

wherein the transparency-adjusting pattern features are provided in sets in said sections at the rear side of the substrate, respectively, such that the density of the set of the features in one of said sections differs from that of the set of features in another of said sections, whereby when the illumination is directed through the substrate from the rear side thereof with a uniform intensity, the intensity of the illumination incident on the main pattern has variations corresponding to the different densities, in each of the sections, of the respective sets of transparency-adjusting pattern features.

14. The method of claim 13, and further comprising transferring an image of the main pattern to a wafer by performing an exposure process in which the illumination is directed onto the wafer through the photomask, and developing the image to form a pattern on the wafer formed of elements having critical dimensions, before the transparency-adjusting pattern features are provided at the rear side of the substrate, and

wherein the different densities at which the transparency-adjusting pattern density values are provided are based upon a distribution of the critical dimensions of the elements on the of the pattern formed on the wafer by the transferring of the image of the main pattern to the wafer.

15. A method of manufacturing a photomask, the method comprising:

providing a photomask that includes a substrate having a front side and a rear side, and a main pattern located at said front side of the substrate;

dividing a region at the rear side of the substrate into a plurality of sections including a first section and a second section; and

providing a transparency-adjusting pattern layer, capable of changing the intensity of illumination directed through the rear side of the photomask and onto the main pattern, in said sections at the rear side of the substrate such that a first part of said transparency-adjusting pattern layer resides in said first section and a second part of said transparency-adjusting pattern layer resides in said second section, and

wherein said first part of the transparency-adjusting pattern layer is formed at said first section with uniform characteristics with respect to its ability to change the intensity of that portion of the illumination passing through the first section, said second part of the transparency-adjusting pattern layer is formed at said second section with uniform characteristics with respect to its ability to change the intensity of that portion of the illumination passing through the second section, and the characteristics of said first part of the transparency-adjusting pattern layer in said first section are different from the characteristics of said second part of the transparency-adjusting pattern layer in said second section, whereby when illumination is directed through the rear side of the substrate and onto the main pattern, the intensity of the illumination passing through the first section and incident

on the main pattern differs from the intensity of the illumination passing through the second section and incident on the main pattern.

16. The method of claim 15, and further comprising transferring an image of the main pattern to a wafer by performing an exposure process in which the illumination is directed onto the wafer through the photomask, and developing the image to form a pattern on the wafer formed of elements having critical dimensions, before the transparency-adjusting pattern layer is provided at the rear side of the substrate, and

wherein the different characteristics of the first and second parts of the transparency-adjusting pattern layer are provided based upon a distribution of the critical dimensions of the elements on the of the pattern formed on the wafer by the transferring of the image of the main pattern to the wafer.

17. A method of manufacturing a photomask, the method comprising:

providing a photomask that includes a substrate having a front side and a rear side, and a main pattern located at said front side of the substrate;

transferring an image of the main pattern to a wafer by directing illumination onto the wafer through said photomask in an exposure process, and using the image to produce a pattern on the wafer formed of elements having critical dimensions;

quantifying the critical dimensions to obtain a distribution of values of the critical dimensions on the wafer;

comparing the critical dimension values to a reference critical dimension value in order to ascertain the differences therebetween;

determining, in relation to localities on the photomask, degrees to which the intensity of the illumination used in the exposure process would need to be decreased in order to reduce the differences, respectively, between the critical dimension values and the reference critical dimension value, thereby obtaining a distribution of said degrees in relation to said localities; and

providing a light-shielding layer, having a light-absorbing characteristic, on a rear side of the photomask substrate so that the intensity of the illumination directed through the rear side of the substrate and onto the main pattern will be reduced by the light-shielding layer, and

wherein the light-absorbing characteristic is varied across said light-shielding layer in correspondence with said distribution of the degrees to which the intensity of illumination needs to be decreased.

18. The method of claim 17, wherein the light-absorbing characteristic is proportional to the thickness of said light-shielding layer, and said providing a shielding layer comprises forming the light-shielding layer with a thickness that varies in correspondence with said distribution of the degrees to which the intensity of illumination needs to be decreased.

19. A photomask comprising:

a photomask substrate having a front side and a rear side;

a main mask pattern disposed on the front side of said substrate; and

a transparency-adjusting pattern layer disposed on a rear side of said substrate,

said transparency-adjusting pattern layer including sets of transparency-adjusting pattern features, capable of changing the intensity of illumination directed through the rear side of the photomask and onto the main pattern, in respective sections at the rear side of the substrate,

each set of the transparency-adjusting pattern features having a density in that is a function of the size and spacing of the features and is proportional to the change that the features will make in the intensity of the illumination when the illumination is directed through the respective section at the rear side of the substrate, and

the density of the set of said transparency-adjusting pattern features in one of said sections being different from that of the set of transparency-adjusting pattern features in another of said sections, whereby when the illumination is directed through the photomask substrate from the rear side thereof with a uniform intensity, the intensity of the illumination incident on the main pattern has variations corresponding to the different densities, in each of the sections, of the respective sets of said transparency-adjusting pattern features.

20. The photomask of claim 19, wherein the densities of the sets of the transparency-adjusting pattern features vary within a range of about 0 – 5 % amongst said sections at the rear side of the photomask substrate.

21. The photomask of claim 19, wherein the transparency-adjusting pattern features each have a size wherein the maximum width is about 0.8 μm.

22. The photomask of claim 19, wherein the transparency-adjusting pattern features are recesses in the rear side of said photomask substrate.

23. The photomask of claim 19, wherein the transparency-adjusting pattern features comprise material capable of reflecting or absorbing the illumination incident thereon.

24. The photomask of claim 23, wherein said material is chromium.

25. The photomask of claim 19, and further comprising a transparent auxiliary mask substrate disposed on the rear side of said photomask substrate, and wherein the transparency-adjusting pattern features are located on said auxiliary mask substrate.

26. The photomask of claim 25, wherein the transparency-adjusting pattern features are recesses in one side of the auxiliary mask substrate.

27. The photomask of claim 25, wherein the transparency-adjusting patterns comprise material covering a side of said auxiliary mask substrate and capable of reflecting or absorbing the illumination incident thereon.

28. The photomask of claim 27, wherein said material is chromium.

29. A photomask comprising:

a photomask substrate having a front side and a rear side;

a main mask pattern disposed on the front side of said substrate; and

a transparency-adjusting pattern layer disposed on a rear side of said substrate,

said transparency-adjusting pattern layer being capable of changing the intensity of illumination directed through the rear side of the photomask and onto the main pattern, a first part of said transparency-adjusting pattern layer residing in a first section of a region at the rear side of said mask substrate, and a second part of said transparency-adjusting pattern layer residing in a second section of said region,

said first part of the transparency-adjusting pattern layer in said first section having uniform characteristics with respect to its ability to change the intensity of that portion of the illumination passing through the first section, said second part of the

transparency-adjusting pattern layer having uniform characteristics with respect to its ability to change the intensity of that portion of the illumination passing through the second section, and the characteristics of said first part of the transparency-adjusting pattern layer in said first section being different from the characteristics of said second part of the transparency-adjusting pattern layer in said second section, whereby when illumination is directed through the rear side of said photomask substrate and onto the main pattern, the intensity of the illumination passing through the first section and incident on the main pattern will differ from the intensity of the illumination passing through the second section and incident on the main pattern.

30. An exposure method for use in photolithography, the method comprising:

providing a photomask that includes a substrate having a front side and a rear side, and a main pattern located at said front side of the substrate;

transferring an image of the main pattern to a wafer by directing illumination onto the wafer through said photomask in a first exposure process, and using the image to produce a pattern on the wafer formed of elements having critical dimensions;

quantifying the critical dimensions to obtain a distribution of values of the critical dimensions on the wafer;

comparing the critical dimension values to a reference critical dimension value in order to ascertain the differences therebetween;

determining, in relation to localities on the photomask, degrees to which the intensity of the illumination used in the exposure process would need to be decreased in order to reduce the differences, respectively, between the critical dimension values and the reference critical dimension value, thereby obtaining a distribution of said degrees in relation to said localities;

providing a transparency-adjusting layer on the rear side of the photomask substrate, the transparency-adjusting layer being capable of changing the intensity of illumination directed through the rear side of the photomask and onto the main pattern, and

wherein the characteristics of the transparency-adjusting layer with respect to its ability to change the intensity of the illumination are varied in accordance with said distribution of the degrees to which the intensity of the illumination used in the exposure process needs to be decreased; and

subsequently transferring the image of the main pattern onto a wafer by performing a second exposure process using the photomask substrate having the transparency-adjusting layer at the rear side thereof.

31. The method of claim 30, wherein the reference critical dimension value is the smallest of the critical dimension values.

32. The method of claim 30, and further comprising :

selecting transparency-adjusting pattern features that, if provided in a set at a rear side of the substrate of the photomask during the exposure process, would change the intensity of the illumination passing through the photomask during the exposure process due to the density of the features in terms of their size and spacing;

obtaining a correlation between the densities of the transparency-adjusting pattern features, in terms of their size and spacing, and the changes that the transparency-adjusting pattern features provided at those densities at the rear side of the substrate would make in the intensity of the illumination directed therethrough during the exposure process; and

based on said correlation, ascertaining the densities of the transparency-adjusting pattern features that correspond to said distribution of the degrees to which the intensity of the illumination needs to be decreased, to thereby obtain a distribution of the densities of the transparency-adjusting pattern features in relation to said localities, and

wherein said providing a transparency-adjusting layer comprises providing sets of the transparency-adjusting pattern features in sections of a region at the rear side of the photomask substrate, respectively, and laying out the sets of the transparency-adjusting pattern features in said sections, respectively, such that the densities of the respective sets thereof have a correspondence with said distribution of the densities obtained based on said correlation.

33. The method of claim 32, wherein said obtaining a correlation between the densities of the transparency-adjusting pattern features and the changes that the transparency-adjusting pattern features would make in the intensity of the illumination during the exposure process comprises:

forming an arbitrary arrangement of the selected the transparency-adjusting pattern features at the rear side of the photomask substrate, the arrangement comprising an arbitrary size of the transparency-adjusting pattern features spaced apart an arbitrary distance from each other;

using a Fourier transform, determining the intensity of illumination incident on the main pattern after the illumination has been modified by the arbitrary arrangement of the transparency-adjusting pattern features in the exposure process as a function of the size and the spacing of the arrangement of the selected the transparency-adjusting pattern features; and

based on said function, obtaining a correlation between the densities of the transparency-adjusting pattern features, represented by $\frac{(\textit{the size of the features})^2}{(\textit{the spacing of the features})^2}$, and the changes that the transparency-adjusting pattern features would make in the intensity of the illumination during the exposure process.

34. The method of claim 33, wherein the intensity of illumination is represented by $\frac{1-4(\textit{the size of the features})^2}{(\textit{the spacing of the features})^2}$ in said function.

35. The method of claim 32, wherein said determining degrees to which the intensity of the illumination used in the exposure process would need to be decreased comprises:

ascertaining dose latitude values representative of variations in a critical dimension of a pattern formed by an exposure process with respect to changes in the dose of the illumination used to form the pattern; and

calculating exposure dose variations, corresponding to the differences between the critical dimension values and the reference critical dimension value, using the dose latitude values and said differences.

36. The method of claim 32, wherein the second exposure process is performed using the same form and type of illumination as used in the first exposure process.